Conservation of Energy in a Constant Electric Field

Whenever a body falls, its potential energy is changed to kinetic energy; that is,

$$\Delta \mathbf{E_p} = \Delta \mathbf{E_k}$$

An expression for $\Delta \mathbf{E_p}$ when a charge **q** "falls" between two charged plates in a uniform field is derived from:

$$\Delta \mathbf{V} = \frac{\Delta \mathbf{E_p}}{\mathbf{q}} \quad \rightarrow \quad \Delta \mathbf{E_p} = \mathbf{q}\Delta \mathbf{V}$$

where $\Delta \mathbf{V}$ is the voltage between the charged plates.

Meanwhile: $\Delta \mathbf{E_k} = \frac{1}{2}\mathbf{mv_f^2} - \frac{1}{2}\mathbf{mv_i^2}$

→ therefore $\quad \mathbf{q}\Delta \mathbf{V} = \frac{1}{2}\mathbf{mv_f^2} - \frac{1}{2}\mathbf{mv_i^2} \qquad$ **(1)**

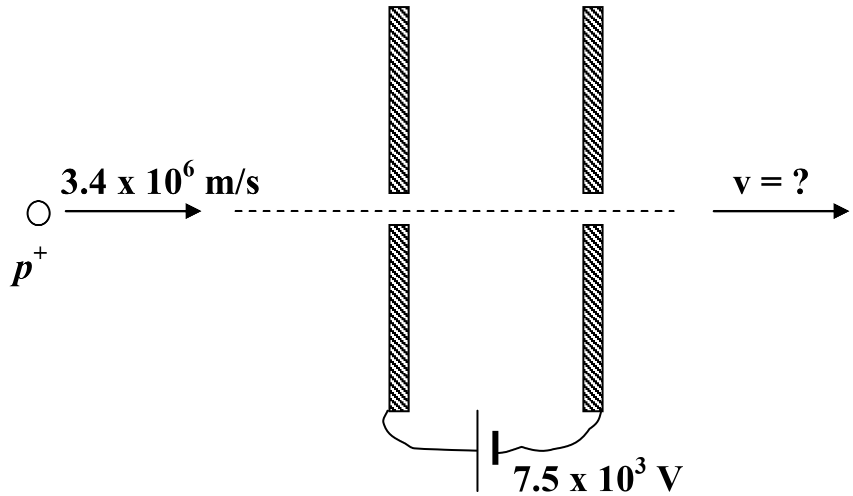
If the charged particle "falls" from rest from one plate to another, then the initial $\mathbf{E_k = 0}$.

→ we therefore get $\quad \mathbf{q}\Delta \mathbf{V} = \frac{1}{2}\mathbf{mv_f^2} \qquad$ **(2)**

Formulas **(1)** and **(2)** are common derivations for calculating the speed of charged particles in a constant field. Make sure you understand this process.

Also note that the voltage $\Delta \mathbf{V}$ is sometimes referred to as *accelerating* voltage, because it is responsible for causing particles to accelerate while passing through the electric field.

Example 14. A proton travelling at 3.4×10^6 m/s passes through an electric field as shown below. How fast will the proton be going after it emerges from the field?



(see Electrostatics Ex 14 for answer)